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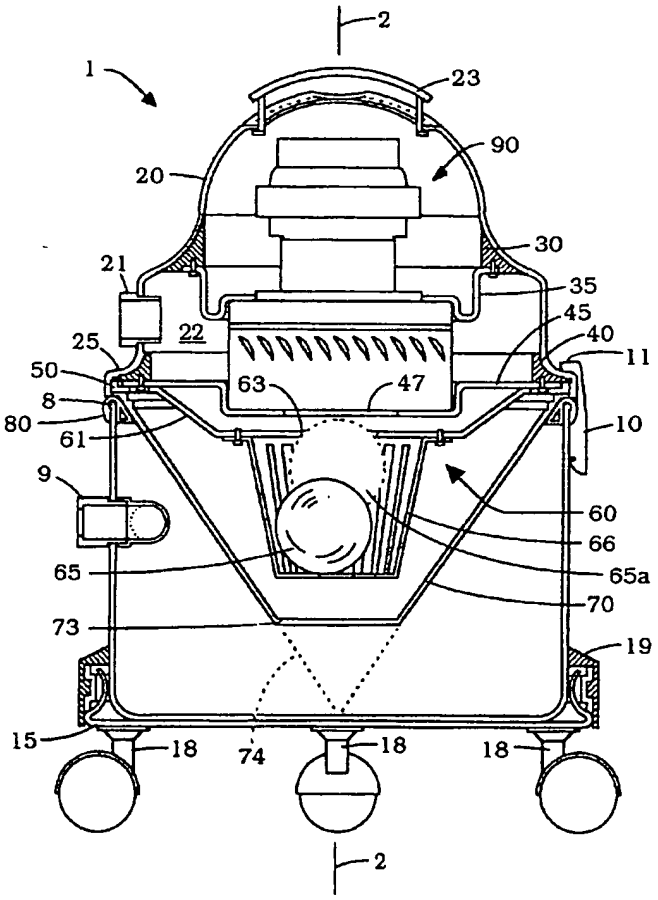
(54) **ASPIRATEUR POUR DETRITUS SECS OU HUMIDES ET FILTRE CONNEXE**

(54) **WET/DRY VACUUM CLEANER AND FILTER THEREFOR**



(57) A vacuum cleaner for both wet and dry operations includes a debris canister within which a cyclonic suction / exhaust flow that carries vacuumed debris may be established, a vacuum fan and motor housing, a vacuum fan and motor assembly mounted substantially within the housing, and an inverted conical filter. The filter is pre-formed from a self-supporting, porous material for filtering debris carried by the suction / exhaust flow and also permits the passage of water. It may have the configuration of a truncated cone. The vacuum cleaner may also include a valve assembly positioned to limit the accumulation of liquid debris within the debris canister to a threshold level.

ABSTRACT

A vacuum cleaner for both wet and dry operations includes a debris canister within which a cyclonic suction / exhaust flow that carries vacuumed debris may be established, a vacuum fan and motor housing, a vacuum fan and motor assembly mounted substantially within the housing, and an inverted conical filter. The filter is pre-formed from a self-supporting, porous material for filtering debris carried by the suction / exhaust flow and also permits the passage of water. It may have the configuration of a truncated cone. The vacuum cleaner may also include a valve assembly positioned to limit the accumulation of liquid debris within the debris canister to a threshold level.

THE EMBODIMENTS OF THE INVENTION IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A vacuum cleaner, comprising:

(a) a debris canister for receiving vacuumed debris, said canister including:

(i) a side wall extending around a central axis upwardly from a closed bottom end of said canister to an open top end of said canister; and,

(ii) an inlet port;

(b) a vacuum fan and motor housing including an exhaust port;

(c) a vacuum fan and motor assembly mounted substantially within said housing and operable to establish a suction/exhaust flow along a path extending first inwardly to said debris canister through said inlet port, then through said debris canister, then through said housing, then outwardly through said exhaust port of said housing; and,

(d) an inverted, conical filter pre-formed from a self-supporting, porous material for filtering debris carried by said flow, said filter extending in axial alignment with said central axis downwardly within said canister from an open top end of said filter to a closed bottom end of said filter.

2. A vacuum cleaner as defined in claim 1, wherein said inlet port extends through said side wall and is oriented to direct said flow into said debris canister with a substantial component of said flow being directed tangential to said axis.

3. A vacuum cleaner as defined in claim 2, wherein said filter has the configuration of a truncated cone.

4. A vacuum cleaner as defined in claim 1, 2 or 3, further including means for limiting the accumulation of liquid debris within the debris canister if the level of such liquid reaches a threshold level.

5. A vacuum cleaner as defined in claim 1, 2 or 3, further including a valve assembly positioned between said filter and said fan and motor assembly, said valve assembly being responsive to the accumulation of liquid debris to block said flow and the accumulation of

further liquid debris if the level of liquid debris within said canister reaches a threshold level.

6. A vacuum cleaner as defined in claim 5, wherein the height of said cone is at least 50% of the height that would result if said filter had the configuration of an untruncated cone.

7. A vacuum cleaner as defined in claim 5, wherein the height of said cone is about 80% of the height that would result if said filter had the configuration of an untruncated cone.

8. A vacuum cleaner as defined in claim 1, wherein said debris canister includes a gasket fitted circumferentially around said top end of said canister, said filter being sized such that a top outer periphery of said filter receives upward holding support from said gasket.

9. A vacuum cleaner as defined in claim 8, wherein said vacuum fan and motor housing is releasably clampable to said canister, said vacuum cleaner further including:

(i) a lower mounting plate for supporting said motor and fan assembly within said housing; and,

(ii) a mounting plate gasket fitted circumferentially around and inwardly beneath an outer perimeter of said mounting plate, said mounting plate gasket bearing downwardly against said top end of said filter when said housing is clamped to said canister as aforesaid.

10. A vacuum cleaner as defined in claim 9, further including a valve assembly positioned between said filter and said fan and motor assembly, said valve assembly being responsive to the accumulation of liquid debris to block said flow and the accumulation of further liquid debris if the level of liquid debris within said canister reaches a threshold level.

11. A vacuum cleaner as defined in claim 10, wherein said valve assembly is secured to an underside of said lower mounting plate.

12. A filter for use in a vacuum cleaner having a debris canister with a circular open top end and a closed bottom end, a vacuum fan and motor housing releasably clampable to said debris canister to close said top end, and a vacuum fan and motor assembly mounted substantially within said housing and operable to establish a suction/exhaust flow along a path extending first inwardly to said debris canister through an inlet port of said canister, then through said canister, then through said housing, then outwardly through an exhaust port of said housing, said filter being characterized by:

a conical shape pre-formed from a self-supporting, porous material for filtering debris carried by said flow, said filter being configured to extend as an inverted cone in axial alignment with a central axis of said canister and downwardly within said canister from an open top end of said filter to a closed bottom end of said filter, said top end of said filter having a diameter approximately equal to the circular diameter of said top end of canister.

13. A filter as defined in claim 12, wherein said filter has the configuration of a truncated cone.

14. A vacuum cleaner as defined in claim 13, wherein the height of said cone is at least 50% of the height that would result if said filter had the configuration of an untruncated cone.

15. A vacuum cleaner as defined in claim 13, wherein the height of said cone is about 80% of the height that would result if said filter had the configuration of an untruncated cone.

WET/DRY VACUUM CLEANER AND FILTER THEREFOR

FIELD OF THE INVENTION

The present invention relates to vacuum cleaners, and particularly to a canister-type vacuum cleaner and associated filter that may be used for both wet and dry pickup.

BACKGROUND TO THE INVENTION

Canister-type vacuum cleaners are well known. As is indicated in U.S. Patent No. 5,248,323 (Stevenson) granted on September 28, 1993, they may normally include a conical filter that extends downwardly into the canister for removing dirt and debris that is carried by air coming into the canister. The air itself is preferably directed to establish a desirable vortex or cyclonic flow within the canister. A conical filter is compatible with such flow and provides a maximized surface area for filtering action. Generally, however, the filter media is structurally weak and requires added mechanical support to be stabilized and held within the canister. Typically, a conical filter will be a simple paper or cellulose fibre filter unsuited for wet operations or, as in the case of the Stevenson patent, it may be a layered structure that additionally includes a special purpose material such as a material containing activated charcoal to remove gaseous impurities. Required mechanical support is often provided in the form of a perforated rigid plastic cage or the like that conforms with the desired conical shape of the filter and against which the filter may depend under pressure. With exposure to water or other liquid, such filters may simply degrade, and they are typically not washable and reusable.

Wet/dry vacuum cleaners are also well known. For example, U.S. Patent No. 5,455,983 (Crouser et al.) granted on October 10, 1995, discloses a vacuum cleaner that may be selectively used for wet or dry pickup operations depending upon the positioning of a valve door. The design of Crouser et al. includes an outer tank and an inner tank, the latter of which is essentially intended to receive and hold dry pickup. A plenum region between the inner tank and the outer tank is essentially intended to receive and hold liquid pickup. If desired, the inner tank can be removed. The design includes a valve assembly positioned between a filter and a fan and motor assembly, such valve assembly being

responsive to the inadvertent accumulation of liquid debris in the inner tank (or the deliberate accumulation of liquid debris in the outer tank with the inner tank removed) to block vacuum flow and thereby inhibit the accumulation of further liquid debris if the liquid level reaches a threshold level. However, as in the case of the conical filters noted above, the filter media is structurally weak. The filter used takes mechanical support from a cage of the valve assembly, but this is at the sacrifice of a considerable amount of surface area used for filtering action. Further, it is not clear from the disclosure in Crouser et al. whether the filter may be washed and reused because they do not describe the filter material.

It is an object of the present invention to provide a new and improved vacuum cleaner that is suitable for wet/dry operations, including a filter that is easily installed and removed without the need for support structures such as a filter cage, that presents a substantial surface area for filtering action, and that is compatible with a cyclonic flow.

SUMMARY OF THE INVENTION

In accordance with the present invention, there is provided a vacuum cleaner comprising a debris canister for receiving vacuumed debris, a vacuum fan and motor housing, a vacuum fan and motor assembly mounted substantially within the housing, and an inverted conical filter. The debris canister includes a side wall extending around a central axis upwardly from a closed bottom end of the canister to an open top end of the canister. Further, the debris canister includes an inlet port. To establish a cyclonic flow within the canister, the inlet port preferably extends through the side wall and is oriented to direct flow into the canister with a substantial component of the flow being directed tangential to the central axis of the canister.

The vacuum fan and motor housing includes an exhaust port. The vacuum fan and motor assembly is operable to establish a suction/exhaust flow along a path extending first inwardly to the debris canister through the inlet port of the canister, then through the debris canister, then through the housing, then outwardly through the exhaust port of the housing.

The conical filter is pre-formed from a self-supporting, porous material for filtering debris carried by the suction/exhaust flow. It extends in axial alignment with the central axis of the canister and downwardly within the canister from an open top end of the filter to a closed bottom end of the filter. To improve durability and handling safety, and to increase the volume space for particulate debris within the canister, the filter advantageously may have the configuration of a truncated cone. However, the amount of truncation should not be excessive because the effective surface area of the filter that is exposed for filtering action will be reduced. Further, the space available for a valve assembly as described below will be reduced. Generally, it is considered that the truncated height should be at least 50% of the height (and preferably nearer to 80% of the height that would result if the filter had the configuration of an untruncated cone.

In preferred embodiment, the vacuum cleaner includes means for limiting the accumulation of liquid debris within the debris canister if the level of such liquid reaches a threshold level. Such a limitation may be readily achieved utilizing a conventional valve assembly positioned between the filter and the vacuum fan and motor assembly, the valve assembly being responsive to the accumulation of liquid debris to block the suction/exhaust flow and the accumulation of further liquid debris if the level of liquid debris within the canister reaches the threshold. For simplicity of construction, the valve assembly may be advantageously secured to the underside of a plate which is in turn secured to the vacuum fan and motor housing and which is also serves as a mount for the vacuum fan and motor assembly. When the housing, the vacuum fan and motor assembly, and the valve assembly are assembled together, they then form a unit which is normally clamped to the debris canister, but which can be simply unclamped and lifted away to permit easy installation or removal of the filter. When clamped, the filter is advantageously secured between a pair of gaskets, one of which gaskets is fitted to the debris canister, the other which is fitted to the plate which is also used to support the valve assembly and the vacuum fan and motor assembly.

The foregoing and other features and advantages of the invention will now be described with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a section elevation view of a vacuum cleaner in accordance with the present invention.

Fig. 2A is an exploded section elevation view of the upper portion of the vacuum cleaner shown in Fig. 1.

Fig. 2B is an exploded section elevation view of the lower portion of the vacuum cleaner shown in Fig. 1 and is a continuation from Fig. 2A.

Fig. 3 is a top view of the upper mounting ring shown in Figs. 1 and 2A.

Fig. 4 is a top view of the upper mounting plate shown in Figs. 1 and 2A.

Fig. 5 is a top view of the lower mounting ring shown in Figs. 1 and 2A.

Fig. 6 is a top view of the lower mounting plate shown in Figs. 1 and 2A.

Fig. 7 is a top view of the suction shut off plate shown in Figs. 1 and 2A.

Fig. 8 is a top view of the ball cage shown in Figs. 1 and 2A.

Fig. 9 is a top view of the filter shown in Figs. 1 and 2B.

Fig. 10 is a top view of the canister shown in Figs. 1 and 2B.

Fig. 11 is a top view of the vacuum fan and motor housing shown in Figs. 1 and 2A.

Fig. 12 is a top view of the vacuum cleaner base shown in Figs. 1 and 2B.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

To improve clarity, not all elements that are shown in section in the drawings include cross-section lines. In each of Figs. 3 and 5, four solid dots indicate the center lines of screw holes that are hidden from view in the particular figure..

In the drawings, the vacuum cleaner generally designated 1 includes a debris canister 5 for receiving vacuumed debris, a vacuum fan and motor housing 20, a vacuum fan and motor assembly generally designated 90, a valve assembly generally designated 60, and an inverted, truncated, conical filter 70 for filtering vacuumed debris. Electrical

connections including an electrical cord, an on/off switch, etc. that are associated with the vacuum fan and motor assembly are common connections that are not shown. Likewise, a cord cover that may be fitted over housing 20 is not shown.

Debris canister 5 is a standard construction that includes a generally cylindrical side wall 6 extending around a central axis 2 upwardly from a closed bottom end 7 of the canister to an open top end 8 of the canister. As well, canister 5 includes an elbow shaped inlet port 9 which is oriented to direct flow into the canister with all or a substantial component of the flow being directed tangential to axis 2. When vacuum cleaner 1 is in operation, this orientation serves to establish a desirable cyclonic flow within canister 5. For the mobility of vacuum cleaner 1 as a whole, canister 5 is carried on a base 15, being gripped therein by four spring clips 16 which form part of the base. As well, base 15 includes four casters 18. A radially symmetric rubber bumper 19 is fitted around the base to protect walls, furniture, etc. against inadvertent scratching or other damage.

Vacuum fan and motor housing 20 contains vacuum fan and motor assembly 90 and includes an exhaust port 21 that communicates between the interior plenum region 22 of the housing and external atmosphere. A carrying handle 23 is also shown. Vacuum fan and motor assembly 90 has not been sectioned in the drawings but is aligned with and is generally symmetric about axis 2. The particular assembly shown is representative of a vacuum fan and motor assembly produced by the Lamb Electric Division of Ametek, Inc., Akron, Ohio (Model No. 116471-13). Accordingly , the assembly per se is not described here in detail.

As shown, assembly 90 is mounted substantially within housing 20 by means of upper and lower mounting rings 30, 40 that are glued to the inner wall of housing 20, and by upper and lower mounting plates 35, 45. Upper mounting plate 35 is connected to the underside of upper mounting ring 30 by means of four screws, and includes a cylindrical sleeve or recess region 36 that is sized to slidingly receive the upper end of fan housing 92 of assembly 90. A central opening 37 in plate 35 permits passage of the upper end of assembly 90. Similarly, lower mounting plate 45 is connected to the underside of lower

mounting ring 40 by means of four screws. It includes a cylindrical sleeve or recess region 46 that is sized to slidingly receive the lower end of fan housing 92 of assembly 90. A central opening 47 in plate 45 enables suction air flow communication from canister 5. A mounting plate gasket 50 is fitted circumferentially around and inwardly beneath the outer perimeter of lower mounting plate 45.

The configuration of upper and lower mounting plates 35, 45 as indicated in the drawings serves to support and secure the representative vacuum motor and fan assembly 90 discussed above. Of course, it will be understood that differing motor and fan assemblies may be used and, depending upon the outer geometry of such assemblies, that the geometry of mounting plates 35, 45 may require corresponding modification.

Valve assembly 60 is bordered in broken outline in Fig. 2A and comprises a suction shut of plate 61, a ball 65 that easily floats in water, and a ball cage 66 that holds ball 65. Plate 61 includes an upper flange 62 which is secured to the underside of lower mounting plate 45 by means of glue. As well, plate 61 includes a centrally disposed circular opening 63 that lies in a plane below top end 8 of canister 5. Ball cage 66 is connected to the underside of plate 61 by means of four screws and includes a plurality of radially spaced slots 67 to allow free air flow. The diameter of opening 63 is less than that of ball 65. In the event that any water or other liquid should rise within cage 66 to a sufficient level, then ball 65 will float upwardly to the broken outline position 65a shown in Fig. 1 to effectively block or seal opening 63.

The inclusion of valve assembly 60 is considered particularly desirable for wet/dry vacuuming operations. While vacuum cleaner 1 with filter 70 described below may be operated in a wet mode without automatic means to limit the level of liquid within canister 5, such operation would not be recommended without frequent visible checks on the amount of liquid accumulation. Otherwise, there would be an increased risk of damage to vacuum fan and motor assembly 90 from accumulating liquid.

When vacuum fan and motor housing 20, vacuum fan and motor assembly 90 and valve assembly 60 are assembled together in the manner described above, they form an

upper unit portion that holds together and that can be lifted and carried about without attachment to debris canister 5. During use, this portion is releasably clamped to canister 5 by means of diametrically opposed clasps 10 attached to side wall 6 of the canister. Only one such clasp is shown in Fig. 1. Clasps 10 are standard clamps, each including a hooked end 11 that releasably engages over the lower skirt perimeter 25 of housing 20 when in the clamping position shown in Fig. 1.

Filter 70 is pre-formed from a self-supporting, porous material such as sintered polyethylene available from MIF Filter Systems Ltd., Cradley Heath, West Midlands, United Kingdom. Desired characteristics of size and shape are achieved by molding. Such a filter can be made strong and durable - providing filtering action for dust and other particulate matter yet permitting the passage of water without structural degradation. It may be washed and reused a number of times.

Filter 70 extends in axial alignment with axis 2 and downwardly within canister 5 from an open top end 71 to a closed bottom end 73. Top end 71 has a circular diameter approximately equal to the circular diameter of top end 8 of canister 5, thus leading towards maximization of the surface area of the filter and also adapting to the canister sealing mechanism as described below. Bottom end 73 could extend to a true conical apex as is indicated by broken outline 74 in Fig. 1. However, the filter may then be more easily damaged by accidental impacts at the apex point. Further, the apex point could represent a potential safety hazard, particularly in home environments, when the filter is removed from the vacuum cleaner for washing or otherwise. Truncation advantageously avoids such problems. Moreover, it serves to increase the volume space available for particulate debris within canister 5.

In the embodiment shown, the truncated height of filter 70 is about 3/4 of the height that the filter would have if it was not truncated. This allows space within the envelope of the filter to accommodate valve assembly 60 without an undue reduction in the effective surface area of the filter. If the truncated height of filter 70 was lessened to below 1/2 of the height that the filter would have if it was not truncated, then the reduction

in surface area could be considered quite significant. For the embodiment shown, the relative size of valve assembly 60 would have to be reduced and, as well, there could be a noticeable increase in the frequency of having to wash and clean the filter. Further, the desired cyclonic flow within canister 5 may be noticeably impaired. For these reasons, it is considered that the truncated height of filter 70 should be at least 1/2 of the height that the filter would have if it was not truncated.

Filter 70 is positioned atop canister gasket 80, the latter of which is radially symmetric and is circumferentially fitted over beaded top end 8 of canister 5. Top end 71 of filter 70 includes a circumferential flange 72 and has a circular diameter approximately equal to the circular diameter of top end 8 of canister 5. As best seen in Fig. 2B, gasket 80 includes a top 81 that merges with an inner sloped surface 82. The slope of surface 82 corresponds to the conical angle of filter 70. When filter 70 is atop gasket 80, the underside of its flange 72 receives upward lifting support from top 81 of the gasket. Further, the upper conical periphery of filter 70 receives upward lifting support from sloped surface 82 of the gasket.

When the upper unit portion of vacuum cleaner 1 is clamped to canister 5 in the manner described above, lower face 51 of mounting plate gasket 50 bears downwardly against top end 71 of filter 70. In effect, the top of filter 70 is thereby sandwiched between gasket 50 and gasket 80 and a dependable seal is established against the escape of dust from canister 5. The bearing of gasket 50 against filter 70 results from the bearing of mounting plate 45 on the gasket. Thus, it will be appreciated that plate 45 is fulfilling several functions including not only the bearing through gasket 50 on filter 70, but also providing support for vacuum fan and motor assembly 90 and support for valve assembly 60.

In use, vacuum fan and motor assembly 90 operates to establish a suction/exhaust flow along a path extending first inwardly to canister 5 through inlet port 9, then in a cyclonic manner through canister 5, then through vacuum fan and motor housing 20, then outwardly through exhaust port 21. In passing through canister 5, the flow necessarily

passes first through filter 70 which serves to extract dust and other particulate matter from the flow, then through opening 63 in suction shut off plate 61, then through opening 47 in lower mounting plate 45.

If water or other such liquid debris is drawn by the flow into canister 5, then initially the liquid will be substantially collected and contained in the lower portion of the canister below filter 70. However, if the level of contained liquid rises above bottom end 73 of the filter, it will also pass through the filter. If the liquid level continues to rise, then ball 65 eventually will come to float. Ultimately, ball 65 will rise to the point where opening 63 is blocked in the manner described above. At this point, the suction/exhaust flow and the accumulation of further liquid will be cut-off because suction will be lost. The threshold liquid level at which such cut-off will occur will be determined by the distance of opening 63 below top end 8 of canister 5, the diameter of opening 63, and the buoyancy and diameter of ball 65.

As has been noted in some instances and as will be apparent to persons skilled in the art, various modifications and changes to the embodiment that has been described can be made without departing from the scope of the present invention. The invention is not to be construed as limited to the particular embodiment that has been described and should be understood as encompassing all those embodiments that are within the spirit and scope of the claims that follow.

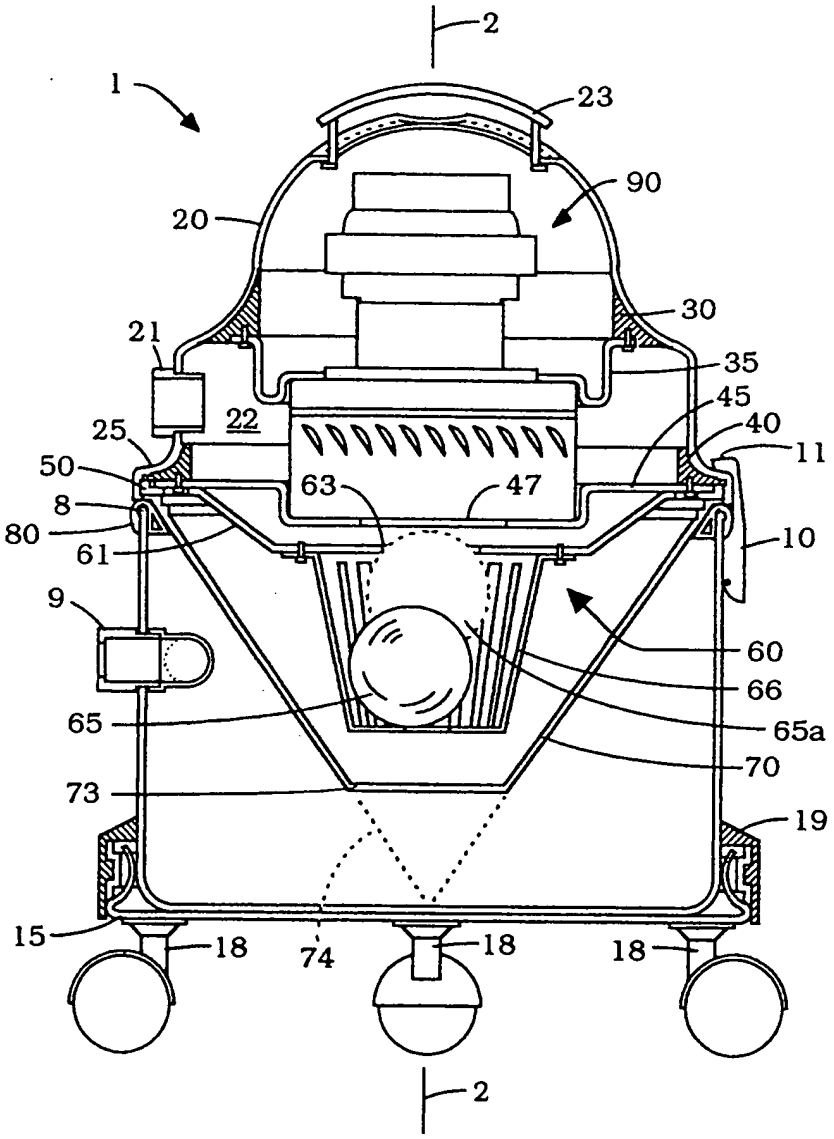

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Fig. 1

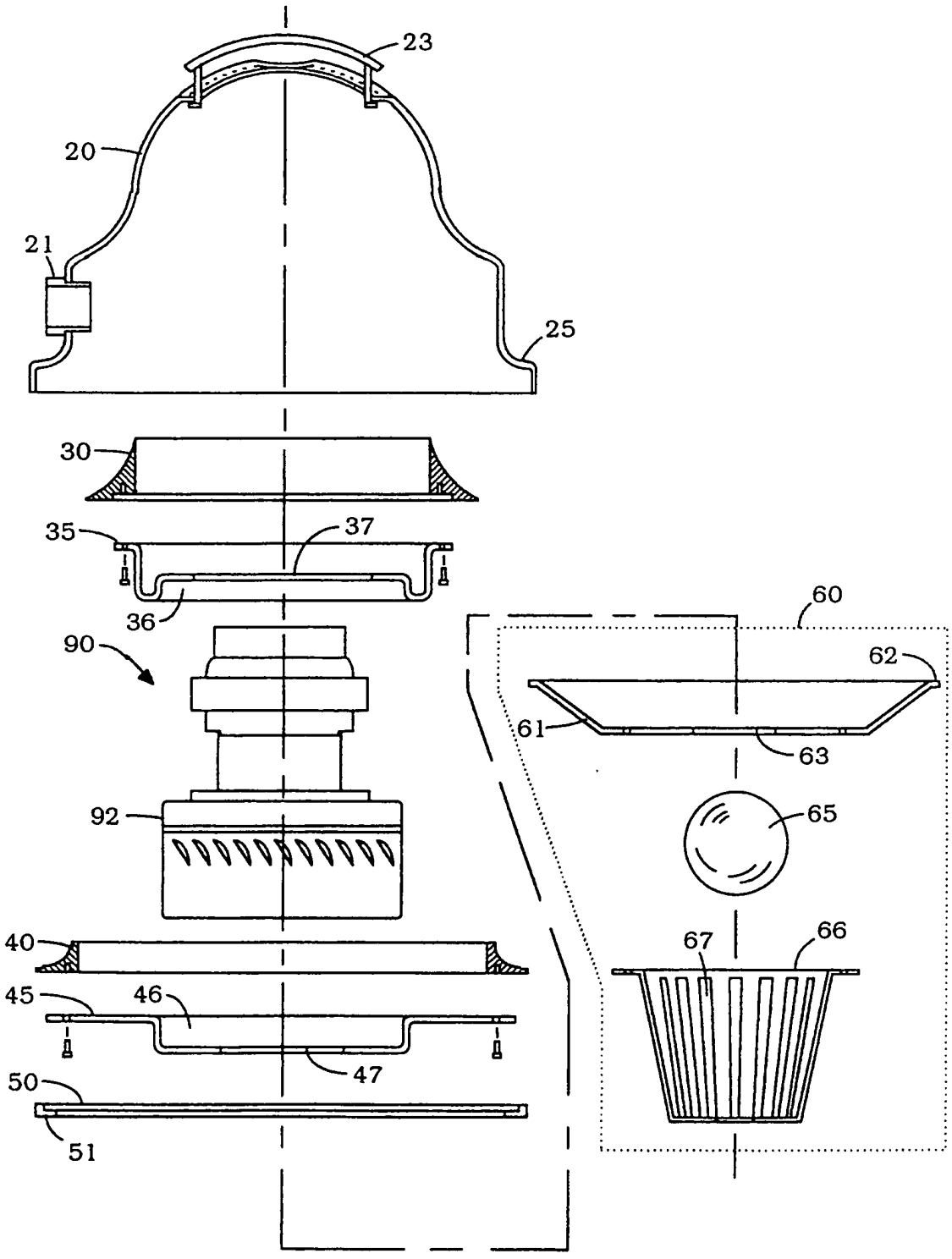

Fig. 2A

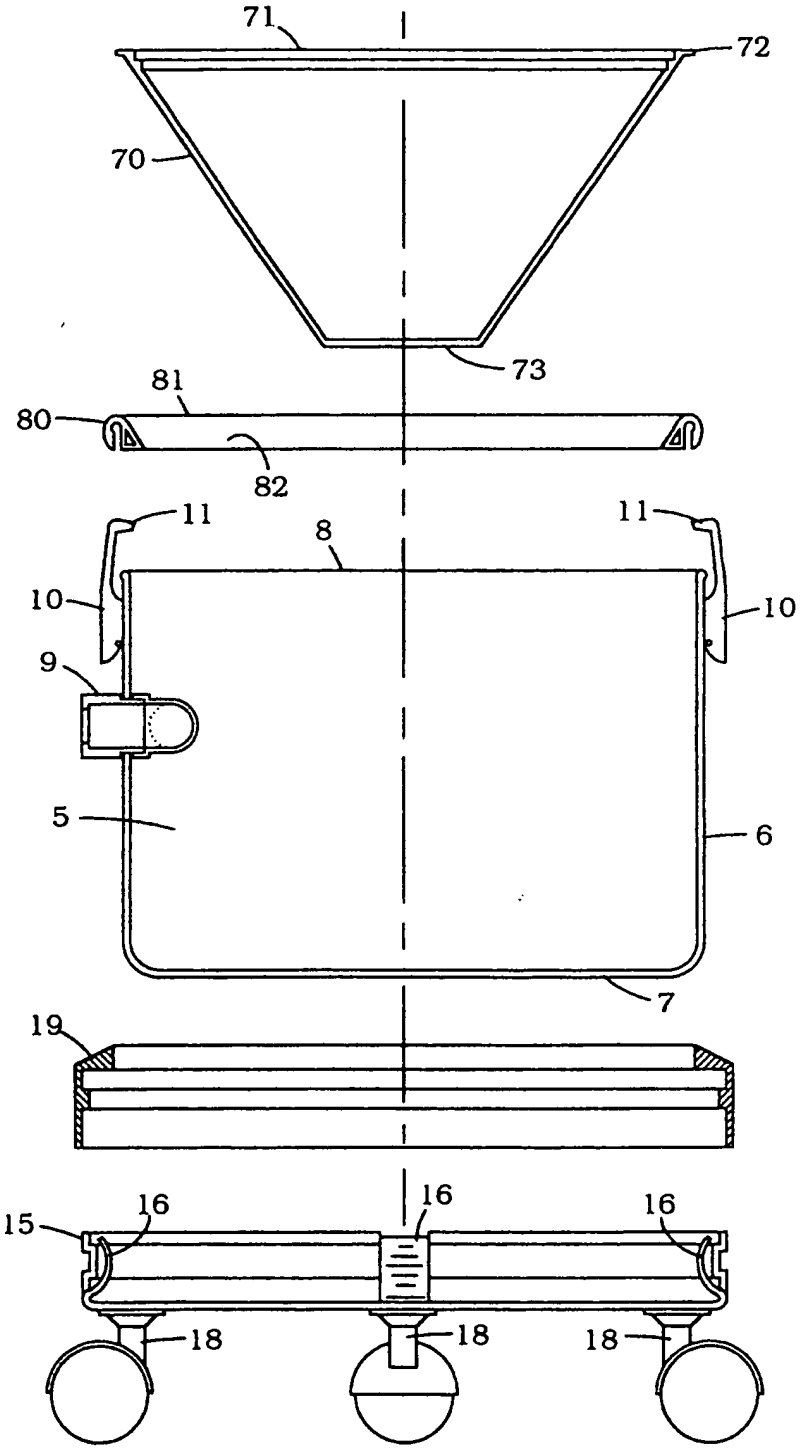

Fig. 2B

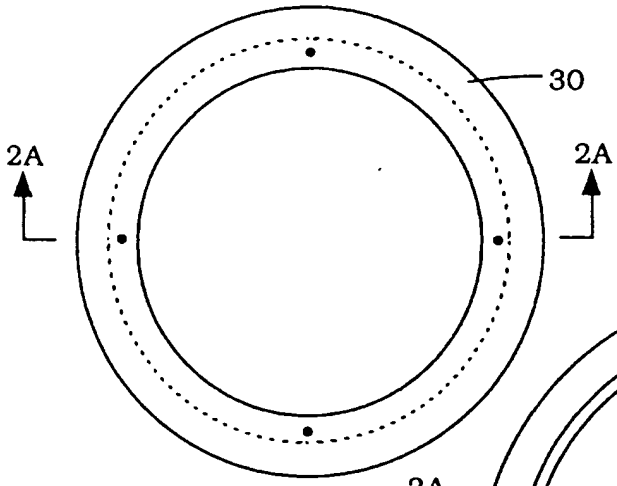

Fig. 3

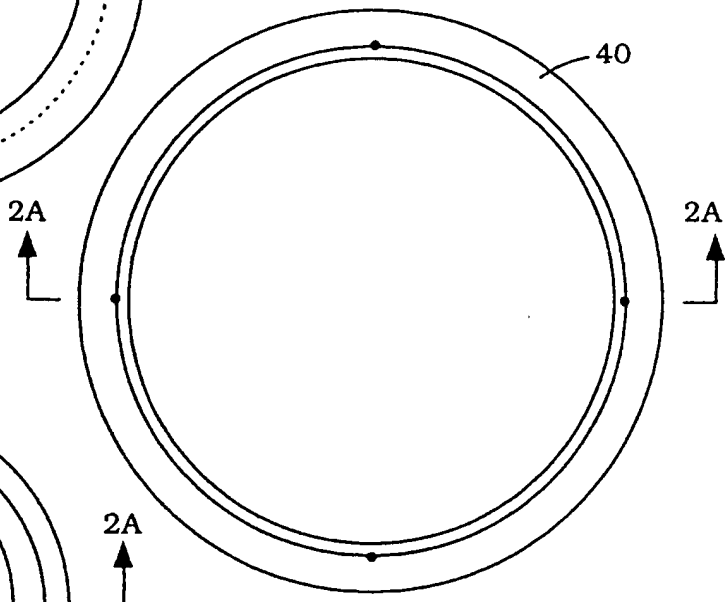

Fig. 5

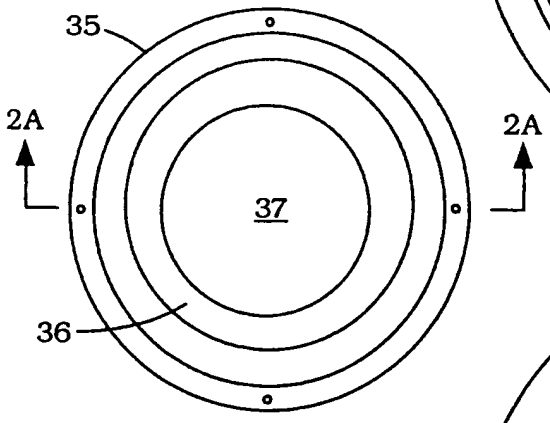

Fig. 4

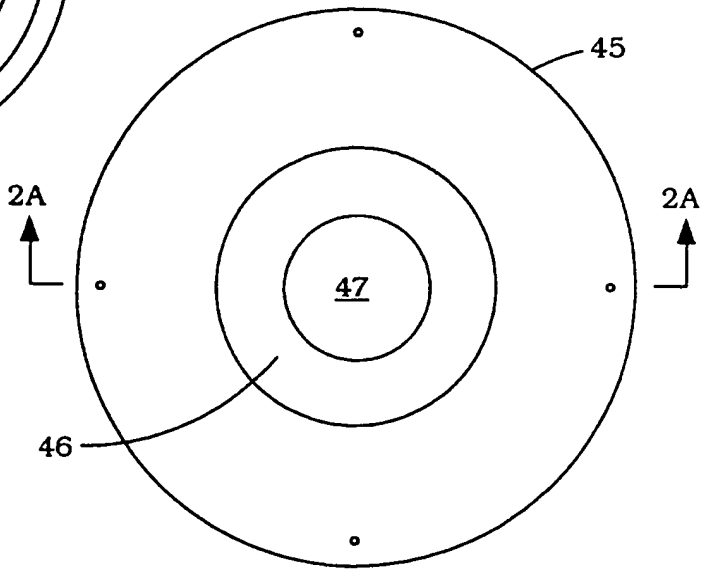

Fig. 6

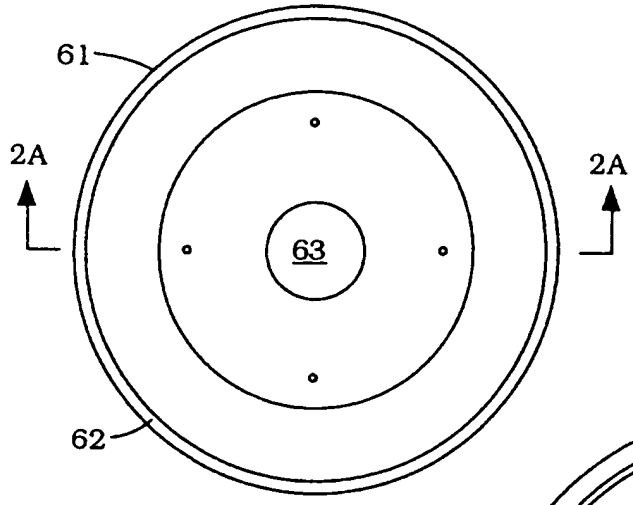

Fig. 7

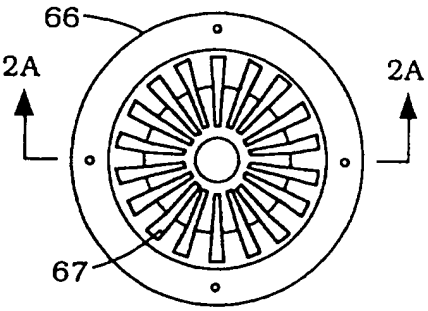

Fig. 8

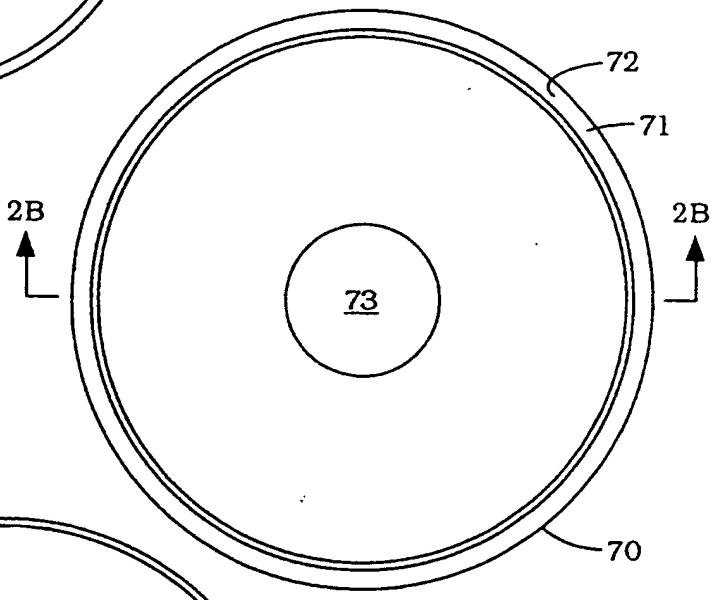

Fig. 9

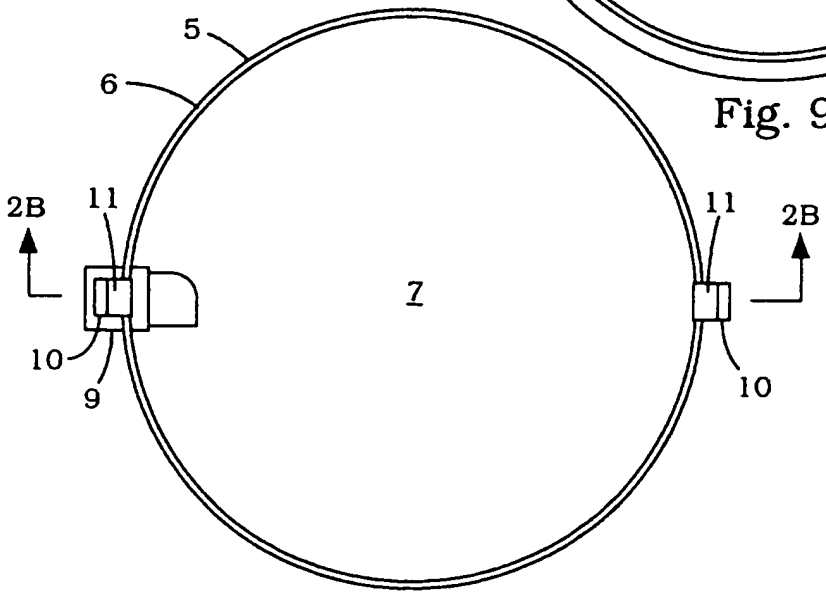

Fig. 10